Application of Risk Assessment Techniques To Evaluate Public Risk and Establish Priorities for Cleanup of Ordnance at Formerly Used Defense Site

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ABSTRACT

The Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS) is a congressionally directed (Public Law 99-190 and 99-499) that authorizes the Secretary of Defense to carry out a program of environmental restoration. Currently on the DERP-FUDS inventory there are over 7000 sites that potentially qualify under this program. Of these 7000 sites, it is currently estimated that over 400 are contaminated with unexploded ordnance (UXO). Since the majority of these UXO sites are now either owned or readily accessible by the general public, it has become necessary as a part of the inventory process to evaluate the public risk to establish priorities for investigation and remediation. This paper will discuss the risk assessment procedure that has been developed by the Huntsville Division and is currently in use to assess public risk of these UXO sites. This procedure was developed, consistent with the MIL-STD 882B, to evaluate the risks associated with the probability and severity of exposure of the general public to these UXO sites.

INTRODUCTION

The Defense Environmental Restoration Program (DERP) is congressionally mandated (Public Law 99-190 and 99-499) and directs the Secretary of Defense to carry out a program of environmental restoration. This mission of environmental restoration has been assigned to the U.S. Army Corps of Engineers (USACE).

The DERP Program allows for the restoration of both active Department of Defense (DOD) sites as well as sites that was formerly used by a DOD component. The program for restoration of active installations is commonly referred to as the Installation Restoration Program (IPR) while the program for restoration of former installations is known as Formerly Used Defense Sites (FUDS).

The DERP goals are (1) to provide for the identification, investigation and cleanup of contamination of hazardous and toxic wastes, (2) to correct other environmental damage which create an imminent and substantial endangerment to the public or the environment, and (3) to dispose of unsafe buildings and structures. The purpose of this paper is to discuss item 2 above with regard to unexploded ordnance on formerly used defense sites.

The Corps of Engineers has been actively establishing a data base of sites meeting the criteria of the DERP-FUDS. That inventory currently stands at over 7,050 sites that fall into the previously mentioned categories of contamination. Of these 7,050 sites, there have been identified 900 formerly used sites that have a high potential for ordnance contamination. With this magnitude of ordnance contaminated sites, it became evident to the USACE, that some mechanisms for evaluating the degree of risk and prioritizing any investigation and remediation effort would be

necessary. On 5 April 1990, an execution policy and criteria for evaluating explosive ordnance (EXO) was established. As a part of this policy, a procedure for evaluating public risks was implemented. This paper will discuss the development of this risk assessment procedure, its application to specific projects and application of this procedure to ordnance contamination on other candidate programs.

RISK ASSESSMENT PROCEDURE DEVELOPMENT

In the initial stages of development of a procedure to evaluate levels of ordnance contamination and prioritize remediation, it became evident that real issue was public exposure to EXO. Ordnance, unlike Hazardous and Toxic Wastes (HTW), was generally not mobile, in effect it had no medium such as groundwater for transport (the exceptions being erosion or ocean transport). The public generally had control of their exposure to EXO, in effect if you did not touch or disturb the EXO the risk was minimal.

The AR 385-10 and MIL-STD 882B establish policy and procedures for evaluating the risks associated with the operation of Army and DOD facilities and equipment. This procedure evaluates the probability of occurrence, as well as the severity of an occurrence. The combination of the two criteria in the form of a risk matrix provide management with a qualitative tool to evaluate the relative risk associated with operation of the particular facility or equipment.

In considering methods for evaluating EXO sites a similarity emerged in that the severity of a mishap was directly related to type of UXO and the probability of a mishap was relevant to the potential for accessibility of the EXO to the public. Applying existing Army and DOD criteria and method to evaluate public risks to EXO would greatly simplify the acceptance of the method plus the method was a proven technique for evaluating risks. The primary differences were (1) that the risks being evaluated were not worker related, they were the general public and (2) the evaluation was not of facilities or equipment but of a piece of land.

HAZARD SEVERITY

In the development of the hazard severity, five general categories of EXO were identified. These categories included (1) conventional ordnance and ammunition (small arms ammunition to bombs), (2) pyrotechniques (incendiary, flares, etc.), (3) bulk high explosives (TNT, HMR, RDX, etc.), (4) propellants (solid and liquid), and (5) chemical agents/weapons (GB, VX, HD, BZ, etc.). Within these 5 categories values were assigned from 0 to 25 based upon the expected hazard associated with public exposure to particular ordnance item. These values were subjective and based upon engineering experience and judgment of the USACE ordnance engineering and explosive safety staff. The Hazard Severity Table is provided by Table A.

TABLE A

HAZARD SEVERITY

Description Value	Category Level	Value
CATASTROPHIC	I	≥21
CRITICAL	II	≥13 <21
MARGINAL	III	≥ 5 <13
NEGLIGIBLE	IV	< 5

HAZARD PROBABILITY

The hazard probability addresses area, extent and accessibility of the EXO to the general public. The areas evaluated include (1) location of contamination (surface, subsurface, within pipes or vessels) (2) proximity to inhabited buildings or structures to the EXO site, (3) the number and type of structure (military, child care, hospital etc.), (4) accessibility of site to the public (i.e., barriers provided), (5) site dynamics that could expose ordnance in the future such as erosion. Within these five categories and subcategories, values were assigned from 0 to 5 based on the potential exposure of the exposure to the EXO. Again these values were based upon sound engineering, experience, and judgment of an ordnance engineering and explosive safety staff. The hazard probability table is provided by Table B.

TABLE B

HAZARD PROBABILITY

Description	Level	Value
FREQUENT	A	≥27
PROBABLE	B	≥21 <27
OCCASIONAL	C	≥15 <21
REMOTE	D	≥ 8 <15
IMPROBABLE	E	<8

RISK MATRIX

While the probability of occurrence and hazard severity assess the risk to the public, a risk matrix must provide guidance to management on actions or mitigative measures that should be implemented. The risk matrix for EXO was developed to provide environmental managers with environmental remediation recommenda-

tion. This Risk Assessment Code (RAC) matrix is shown in Table C. During the initial phases of development of the RAC, 76 EXO sites with good historical information were selected to use as a verification phase for the overall procedure. These 76 sites were independently evaluated using the RAC. Upon completion of this initial assessment, adjustments and refinements were made to better reflect the actual risks of EXO contamination. There was nothing scientific or statistical concerning the verification only practical application of the RAC procedure that has provided a significant level of confidence to the users of the RAC in actual field applications. A summary of RACs for the 76 sites is shown in Table D.

TABLE C

Probability Level		FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
Severity Category:						
CATASTROPHIC	I	1	1	2	3	4
CRITICAL	II	1	2	3	4	5
MARGINAL	III	2	3	4	4	5
NEGLIGIBLE	IV	3	4	4	5	5

RISK ASSESSMENT CODE (RAC)

RAC 1 Imminent Hazard - Emergency action required to mitigate the hazard or protect personnel (i.e., fencing, physical barrier, guards, etc.).

RAC 2 Action required to mitigate hazard or protect personnel. Feasibility study is appropriate.

RAC 3 Action required to evaluate potential threat to personnel. High priority confirmation study is appropriate.

RAC 4 Action required to evaluate potential threat to personnel. Confirmation study is appropriate.

RAC 5 No action required.

TABLE D

Risk Assessment for 76 Selected Sites

RAC	# SITES
1	1
2	15
3	4
4	43
5	13
	76

APPLICATION OF THE RISK ASSESSMENT PROCEDURE

To assist the reader in understanding the RAC procedure, a project was selected to illustrate the procedure. The reader should understand that an EXO site risk assessment must be based upon documented evidence consisting of record searches, reports of Explosive Ordnance Disposal (EOD) detachment actions, field observations, interviews, and measurements. Any field activities should be made with the assistance of qualified EOD personnel.

The site selected for application of the RAC procedure is Mission Trails Park (MTP) San Diego, California, a portion of the former Camp Elliott Marine Corps Base. The following site description has been extracted from the Inventory Project Report (INPR). Additional information necessary to complete RAC were obtained through site visits.

SITE DESCRIPTION

The former Camp Elliott was operated from 1940 until 1960. In 1960 approximately 13,277 acres of the original 32,000 acres were declared excess. As a result, ownership of the property was transferred to the General Services Administration (GSA). The property was disposed of through land swaps, grants, and sales between 1960 and 1963. A portion of the 13,277 acres, (approximately 2,100 acres), is the subject of this report. The City of San Diego has acquired most of this property and is in the process of acquiring the rest of the property for the Mission Trails Regional Park for a park and recreational area.

Following an initial background review and site visit, the western slopes of Fortuna Mountain were identified as the area of highest contamination. The information for the project area is limited, however, there was a clearance sweep of this area in 1973. The 1973 Explosive Ordnance Clearance Sweep was conducted from 16 October to 30 November 1973. This was a visual surface sweep, a total of 933 ordnance-related items were found.

Additional information was collected from the Feasibility Study of Remedial Action Alternatives for Conventional Explosive Ordnance items on the Former Camp Elliott, San Diego, California Final Draft Engineering Report and Environmental Impact Statement 16 October 1987. The Feasibility Study deals with another area of the former Camp Elliott namely Tierrasanta. Tierrasanta is adjacent to the Mission Trails Regional Park and has had several surface and subsurface sweeps conducted to remove ordnance related items. The most recent sweeps were a direct result of the 1983 accident that killed 2 youths and critically injured one more when a 37mm high explosive projectile that they had found exploded. Both areas, Tierrasanta and Mission Trails Regional Park, were part of a special training center on Camp Elliott. It was in these areas that the Marines conducted artillery and anti-tank training. Information on firing sites was not available. The locations of the actual firing sites are not known but they have been approximated by DeYoung Johnson Group, Inc. (DJG) as shown in Figure 2-16. Using these firing site locations, target areas can be projected to show the areas most likely to have contamination. The western slopes of Fortuna Mountain are within the area most likely to be contaminated.

The San Diego Fire Department in 1984 and 1985 responded to 3 reports of possible ordnance near Fortuna Mountain. A total of 8 military rounds (7 each/75mm armour piercing rounds, 1 each/105mm high explosive) were found. In the Tierrasanta area they responded approximately 81 times and found 393 ordnance related items. This is not a complete list of all the items that have been found. This is merely an example of what was found between 1 January 1984 to 26 April 1984 and 15 July 1985 to 25 September 1985 by the San Diego Fire Department. A completed Risk Assessment for this site is provided by Appendix A.

OTHER CANDIDATE PROGRAMS

The development of this RAC procedure for EXO contamination has been for the formerly used defense sites. The RAC was tailored to evaluate public risks. This RAC procedure has potential for evaluating EXO contamination at other than formerly used sites. These include the active installation programs, the base closure programs, the range modernization program, the overseas base closures as well as the superfund program. Modification to the RAC would have to be done to accommodate the risks to be evaluated. For example on the IRP or range program, public exposure would not generally be of concern where worker safety would. For base closures, public safety is obviously of concern particularly with regard to potential land uses through remediation and returning the property back to functional public use. Superfund generally would not deal with military ordnance but there is always the potential for commercial explosives. All of these programs have the need for some type of procedure to address the risk associated with ordnance contamination and the RAC for FUDS offers great potential.

SUMMARY

The Huntsville Division has been designated as the U.S. Army Corps of Engineers Mandatory Center of Expertise (MCX) and Design Center for Explosive Ordnance Engineering for the Army. With this designation, the Huntsville Division has demonstrated an element of technical capability and experience that is necessary to evaluate and remediate sites contaminated with EXO.

This paper has discussed the history of the DERP-FUDS for unexploded ordnance, the development of the RAC procedure for EXO contamination and application of the RAC to an actual project.

EXO is a safety and environmental hazard that has resulted in unreasonable risks to the general public, contractors, and Army personnel. It is felt that this RAC procedure provides our environmental program managers with the necessary tools to evaluate public risks and make the appropriate decision concerning remediation of EXO contaminated sites. The program manager for EXO at the Huntsville Division is Mr. Robert Wilcox at 205-955-5802. The technical manager is Mr. C. David Douthat at 205-955-5785. The mailing address is U.S. Army Corps of Engineers, P.O. Box 1600, ATTN: CEHND-ED-SY/David Douthat or ATTN: CEHND-PM/Rob Wilcox, Huntsville, AL 35807-4301.

APPENDIX A
RISK ASSESSMENT PROCEDURES FOR
EXPLOSIVE ORDNANCE (EXO)

Site Name : Camp Elliott
Site Location : San Diego, CA
DERP Project #: JA09CA006702

Rater's Name: Douthat
Organization: CEHND
RAC : II-A RAC 2

EXO RISK ASSESSMENT:

This risk assessment procedure was developed in accordance with MIL-STD 882B and AR 385-10.

The EXO risk assessment is based upon documented evidence consisting of records searches, reports of Explosive Ordnance Disposal (EOD) detachment actions, and field observations, interviews, and measurements. These data are used to assess the risk involved based upon the hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

Any field activities should be made with the assistance of qualified EOD personnel.

Part I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible mishap resulting from personnel exposure to various types and quantities of unexploded ordnance items.

TYPE OF ORDNANCE

A. Conventional Ordnance and Ammunition

	YES VALUE	NO VALUE	VALUE
Small Arms (.22 cal - .50 cal)	2	0	2
Medium/Large Caliber (20 mm and larger)	10	0	10
Bombs, Explosive	10	0	0
Bombs, Practice (w/spotting charges)	6	0	0
Grenades, Hand and Rifle, Explosive	10	0	10
Grenades, Practice (w/spotting charges)	6	0	6
Landmines, Explosive	10	0	0
Landmines, Practice (w/spotting charges)	6	0	0
Rockets, Guided Missiles, Explosive	10	0	10
Detonators, Blasting Caps	10	0	0

Demolition Charges	10	0	0

Conventional Ordnance and Ammunition ORS Value (Maximum of 10). 10

B. Pyrotechnics

	YES VALUE	NO VALUE	VALUE
Any Munition Containing White Phosphorus or other Pyrophoric Material (i.e., Spontaneously Flammable)	10	0	0
Any Munition Containing A Flame or Incendiary Material (i.e., Napalm, Triethlaluminum Metal Incendiaries)	6	0	0
Military Flares	4	0	0

Pyrotechnics Value (Maximum of 10). 0

C. Bulk High Explosives (Bulk explosives not an integral part of conventional ordnance).

	YES VALUE	NO VALUE	VALUE
Primary or Initiating Explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, etc.)	10	0	0
Booster, Bursting or Fuse Explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	10	0	0
Military Dynamite	10	0	0
Less Sensitive Explosives (Ammonium Nitrate, Favier Explosives, etc.)	3	0	0

High Explosives Value (Maximum value of 10). 0

D. Propellants

	YES VALUE	NO VALUE	VALUE
Solid or Liquid Propellants	6	0	0

E. Chemical Agent/Weapons

	YES VALUE	NO VALUE	VALUE
Radiological	25	0	0
Toxic Chemical Agents (Choking, Nerve, Blood, Blister)	25	0	0
Incapacitating Agent (BZ)	10	0	0
Riot Control and Miscellaneous (Vomiting, Tear, Chlorine, Mustard Simulant)	5	0	0
Any Munition Containing Smoke, Illumination, Signal Charge	4	0	0

Chemical Agent/Weapons Value (Maximum 25). 0

Total Ordnance and Explosive Waste Characteristics Value (Total = A + B + C + D + E with a Maximum value of 61). 10

TABLE 1

HAZARD SEVERITY

Description	Category	Value
CATASTROPHIC	I	≥21
CRITICAL	II	≥13 <21
MARGINAL	III	≥ <13
NEGLIGIBLE	IV	< 5

* Apply Hazard Severity to Table 3.

Part II. Hazard Probability. The probability that a hazard has been or will be created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used DOD site.

AREA, EXTENT, ACCESSIBILITY OF CONTAMINATION

A. Locations of Contamination

	YES VALUE	NO VALUE	VALUE
Within Tanks, Pipes, Vessels or Other confined locations.	5	0	0

On the surface or within 3 feet.	5	0	5
Inside walls, ceilings, or other parts of Buildings or Structures.	4	0	0
Subsurface, greater than 3 feet in depth.	3	0	3

Value for location of UXO. (Maximum Value of 5). 5

B. Distance to nearest inhabited locations or structures likely to be at risk from EXO site (roads, parks, playgrounds, and buildings).

Distance to Nearest Target	VALUE
Less than 1250 feet	5
1250 feet to 0.5 miles	4
0.5 miles to 1.0 mile	3
1.0 mile to 2.0 miles	2
2.0 miles to 5.0 miles	1
Over 5.0 miles	0

Distance to Persons Value (Maximum Value of 5). 5

C. Numbers and types of Buildings within a 2 mile radius measured from the hazardous area, not the installation boundary.

Number of Buildings	VALUE
0	0
1 to 10	1
11 to 50	2
51 to 100	3
101 to 250	4
251 or Over	5

Number of Buildings Value (Maximum Value of 5). 5

D. Types of Buildings

	VALUE
Educational, Child Care, etc.	5
Residential, Hospitals, Hotels, etc.	5

Commercial, Shopping Centers, etc.	5	
Industrial Warehouse, etc.	4	
Agricultural, Forestry, etc.	3	
Detention, Correctional	2	
Military	1	
No Buildings	0	
Types of Buildings Value (Maximum Value of 5).		5

E. Accessibility to site refers to the measures taken to limit access by humans or animals to ordnance and explosive wastes. Use the following guidance:

Barrier	Assigned Value
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel) which continuously monitors and controls entry onto the facility;	0

or

Barrier	Assigned Value
An artificial or natural barrier (e.g., a fence combined with a cliff), which completely surrounds the facility; and a means to control entry, at all times, through the gates or other entrances to the facility (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the facility).	0
Security guard, but no barrier	1
A barrier, (any kind of fence) but no separate means to control entry	2
Barriers do not completely surround the facility	3
No barrier or security system	5
Accessibility Value (Maximum Value of 5).	5

F. Site Dynamics - This deals with site conditions that are subject to change in the future, but may be stable at the present. Examples would be excessive soil errosion by beaches or streams, increasing land development that could reduce distances from the site to inhabitated areas or otherwise increase accessability.

	VALUE	
None Anticipated	0	
Expected	5	
(Maximum Value of 5)		5
Total value for hazard probability. Sum of Values A through F. (Not to exceed 30). Apply this value to Hazard Probability Table 2 to determine Hazard Level.		30

TABLE 2

HAZARD PROBABILITY

Description	Level	Value
FREQUENT	A	≥27
PROBABLE	B	≥21 <27
OCCASIONAL	C	≥15 <21
REMOTE	D	≥ 8 <15
IMPROBABLE	E	<8

* Apply Hazard Probability to Table 3.

Part III. Risk Assessment. The risk assessment value for this site is determined using the following Table 3. Enter with the results of the hazard probability and hazard severity values.

TABLES 1 AND 2

HAZARD SEVERITY - III
(from Table 1)

HAZARD PROBABILITY - A
(from Table 2)

TABLE 3

Probability Level		FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
Severity Category:						
CATASTROPHIC	I	1	1	2	3	4
CRITICAL	II	1	2	3	4	5
MARGINAL	III	2	3	4	4	5
NEGLIGIBLE	IV	3	4	4	5	5

RISK ASSESSMENT CODE (RAC)

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RAC 3 Action required to evaluate potential threat to personnel. High priority confirmation study is appropriate.

RAC 4 Action required to evaluate potential threat to personnel. Confirmation study is appropriate.

RAC 5 No action required.

Justification. In narrative form, summarize the documented evidence that supports this risk assessment.